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SAMPLING AND ANALYSIS PLAN

APPENDIX A

SUPPORTING
SW 1RA

**903 Pad, Mound, and
East Trenches Areas**

Operable Unit No. 2

Volume II



Environmental Restoration Program

September 21, 1990

**U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden, Colorado**

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APPENDIX A SAMPLING AND ANALYSIS PLAN

INTRODUCTION

This Sampling and Analysis Plan (SAP) is specifically written to provide guidance for all field and laboratory work in support of the treatability study on surface water collected from Operable Unit No. 2 at the Rocky Flats Plant. This SAP consists of two documents referred to as Appendix A-1 the Field Sampling Plan (FSP) and Appendix A-2 the Laboratory Analysis Plan (LAP).

The FSP (Appendix-1) describes the site background of Operable Unit No. 2, and specific guidance for field sampling efforts required for this task. The FSP describes sample locations, frequency of sampling, sampling designation, sampling equipment and procedures, sample handling and shipping, and all required documentation procedures.

The LAP (Appendix-2) describes the sampling and analyses efforts during the treatability investigation. The LAP specifies sample identification, chemical analysis method, sampling procedures, frequency of sampling, sample handling and shipping, and all required documentation procedures.

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**APPENDIX A-1
FIELD SAMPLING PLAN**

TABLE OF CONTENTS

	<u>Page</u>
1.0 SITE BACKGROUND	A-1-1
1.1 DESCRIPTION OF SITE	A-1-2
1.1.1 Hydrogeologic Setting	A-1-2
1.1.2 Stratigraphy	A-1-2
1.1.3 Hydrology	A-1-5
1.1.4 Meteorology and Climatology	A-1-11
1.2 SURROUNDING AREAS	A-1-12
1.3 SUSPECTED CONTAMINANT SOURCES	A-1-12
1.4 PROBABLE GROUNDWATER AND SURFACE WATER TRANSPORT PATHWAYS	A-1-16
1.5 CONTAMINANT DISTRIBUTION	A-1-16
1.5.1 Groundwater Contamination	A-1-17
1.5.2 Surface Water Contamination	A-1-20
2.0 SAMPLING OBJECTIVE	A-1-24
3.0 SAMPLE LOCATION AND FREQUENCY	A-1-25
3.1 SAMPLING LOCATIONS	A-1-25
3.2 SAMPLING DATES	A-1-26
3.3 CONSTITUENTS TO BE ANALYZED	A-1-26
3.4 NUMBER OF SAMPLES	A-1-27
4.0 SAMPLE DESIGNATION	A-1-30
5.0 SAMPLING EQUIPMENT AND PROCEDURES	A-1-31
5.1 SAMPLING PROCEDURES	A-1-31
5.2 EQUIPMENT	A-1-31
5.3 DECONTAMINATION	A-1-31
5.4 WASTE MANAGEMENT	A-1-32

TABLE OF CONTENTS (Continued)

	<u>Page</u>
6.0 SAMPLE HANDLING AND DOCUMENTATION	A-1-33
7.0 REFERENCES	A-1-34

LIST OF TABLES

TABLE A-1 VOLUMES OF SURFACE WATER REQUIRED FOR TREATABILITY TESTS	A-1-28
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LIST OF FIGURES

FIGURE A-1	SURFACE WATER SAMPLING SITES AND LOCATION OF ALLUVIUM	A-1-4
FIGURE A-2	POTENTIOMETRIC SURFACE OF THE WATER TABLE	A-1-6
FIGURE A-3	DRAINAGE BASINS	A-1-8
FIGURE A-4	OPERABLE UNIT NO. 2	A-1-10

The Department of Energy (DOE) wishes to pursue an interim remedial action for surface water at the 903 Pad, Mound, and East Trenches Areas, now termed Operable Unit No. 2, at the Rocky Flats Plant (RFP). In accordance with the Resource Conservation and Recovery Act of 1976 (RCRA) as amended by the Hazardous and Solid Waste Amendments of 1984 (HSWA), and the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), an Interim Measures/Interim Remedial Action (IM/IRA) is being conducted to minimize the migration of hazardous substances via surface water from areas that pose a potential long-term threat to the public health and environment. DOE is implementing an IM/IRA Plan because of the length of time it typically takes to finalize a RCRA Facility Investigation/Remedial Investigation (RFI/RI), and Corrective Measures Study/Feasibility Study (CMS/FS).

Organic and inorganic contamination of surface water has resulted from past operational practices no longer permitted under current regulations. The sources of contamination are, in part, within Operable Unit No. 2.

EG&G has prepared an IM/IRA Plan to identify, screen, and evaluate appropriate interim remedial action alternatives, and select the preferred interim remedial action for the contaminated surface water.

1.1 DESCRIPTION OF SITE

The hydrogeology, hydrology, and climate associated with the site will effect sampling activities. These factors are described in the following sections.

1.1.1 Hydrogeologic Setting

The hydrogeologic framework of the area under investigation directly affects the movement, quality, and volumes of groundwater and surface water available for sampling. Therefore, an overview of the hydrogeology is presented to describe hydrogeologic factors that impact sampling. A brief description of the stratigraphy and structural geology is included.

1.1.2 Stratigraphy

The rocks in the Rocky Flats Plant (RFP) area range in age from Precambrian to Holocene. The oldest rocks are the Precambrian gneisses, schists, and quartzites that form the core of the Front Range west of the area. Beneath the area, the Precambrian rocks are at a depth of about 12,000 feet. Stratigraphically above these rocks are sedimentary bedrock formations which range in age from Pennsylvanian to Late Cretaceous, and surficial deposits which range in age from Pleistocene to Holocene. The surficial deposits rest unconformably on the eroded surface of the folded and faulted bedrock formations (U.S. Geological Survey, 1976, p. 3).

1.1.2.1 Surficial Deposits

The surficial units found in the area of this investigation are the Rocky Flats Alluvium (Pleistocene), the Slocum Alluvium (Pleistocene) and a minor area of Holocene or

Pleistocene landslide deposit. The surficial materials are underlain by the Arapahoe Formation (Upper Cretaceous).

Surficial deposits within the RFP area are generally less than 50 feet thick and consist of terrace alluvium, colluvium, and valley-fill alluvium. All of the surficial deposits consist of clay, silt, sand, gravel, cobbles, and frequently boulders. The source of these deposits is primarily the Precambrian quartzite from the mountains to the west, but also includes the sedimentary bedrock and older surficial deposits.

The oldest surficial deposit on the RFP property is the Rocky Flats alluvium, which dominates the topography and hydrology of the entire property. The Rocky Flats Alluvium is a broad planar deposit which, in this area, is an alluvial fan deposited downslope from the mouth of Coal Creek Canyon. Contact springs commonly issue from the base of the Rocky Flats Alluvium. The next youngest formations are the Verdos and Slocum Alluviums. These formations are of little hydrologic importance.

1.1.2.2 Bedrock Formations

The Arapahoe Formation is the uppermost bedrock formation and is either exposed at land surface or covered unconformably by unconsolidated surficial deposits. The Arapahoe Formation is a continental deposit of lenticular sands interbedded with clay. Maximum thickness of the formation in the RFP area is about 270 feet. The contact between this unit and the overlying surficial materials produces intermittent seeps and springs in the investigation area. The Rocky Flats Alluvium contact with the underlying Arapahoe Formation is shown in Figure A-1. Figure A-1 also illustrates the locations of the surface water sampling sites to be considered for use in this investigation. Many of the sites are located near the point of contact between the alluvial and bedrock formations.

Hydrology

The hydrogeologic system exhibits dynamic interaction between groundwater and surface water. Annual fluctuations in the potentiometric surface produce periods during which no flow occurs from seeps in the investigation area.

A discussion of surface water chemistry for the 903 Pad, Mound, and East Trenches Areas is also one of ground-water chemistry as most of the surface water samples collected for this investigation are from seeps that represent the surfacing of groundwater. In addition there is frequent interaction of surface water and groundwater in the drainages. The seeps are ponded water located downslope and southeast of the 903 Pad Area or located downslope and north of the Mound Area and East Trenches Area.

1.1.3.1 Groundwater

Groundwater is present in the Rocky Flats Alluvium, colluvium, and valley fill alluvium under unconfined conditions. Recharge to the water table occurs as infiltration of incident precipitation and as seepage from ditches and creeks. In addition, retention ponds along South Walnut Creek and Woman Creek recharge the valley fill alluvium. Figure A-2 presents the potentiometric surface of the water table measured on December 1, 1987, and the locations of alluvial and bedrock wells in the vicinity of Operable Unit No. 2.

The shallow ground-water flow system exhibits large water level changes in response to precipitation events, stream flow and ditch flow. For example, between mid-April and September, 1986, water level declines of as much as eight feet occur in wells which are completed in valley fill alluvium (U.S. DOE, May 25, 1990, p. 2-14). The water levels

in alluvial wells are highest during the months of May and June. Water levels decline during late summer and fall, as evidenced by wells that go dry during this time of year.

Alluvial groundwater discharges to seeps, springs, surface water drainages, and subcropping Arapahoe formation sandstone at Operable Unit No. 2. Seeps and springs occur at the alluvium/bedrock contact. Groundwater in colluvial materials south of the 903 Pad and East Trenches Areas discharges to the South Interceptor Ditch, and groundwater in valley fill materials discharges to Woman or South Walnut Creeks. Figure A-1 illustrates the location of Woman Creek and South Walnut Creek; the shaded areas of Figure A-1 are the areas overlain by alluvial materials. The dark line bordering the shaded areas delineates the approximate point of contact between alluvium and underlying Arapahoe Formation.

The average ground-water flow velocities in the Rocky Flats Alluvium, Woman Creek Valley fill alluvium, and South Walnut Creek Valley fill alluvium are approximately 84 ft/yr, 145 ft/yr, and 20 ft/yr, respectively. The average ground-water flow velocities calculated for various surficial materials assume the materials are fully saturated year round. However, portions of the Rocky Flats Alluvium, colluvium, and valley fill alluviums are not saturated during the entire year. Thus, dissolved constituents in the shallow flow system do not actually move at the calculated velocities for the entire year.

1.1.3.2 Surface Water

Walnut, South Walnut and Woman Creeks drain the Operable Unit No. 2 site. The subdrainages located in the drainage basins of Walnut, South Walnut and Woman Creeks are represented on Figure A-3. Walnut Creek, Woman Creek and South Walnut Creek flow eastward.

South Walnut Creek

The headwaters of South Walnut Creek have been filled during construction of plant facilities. As a result of this, flow originates from a buried culvert located west of Building 991 (see Figure A-4). Flow in the upper reach of South Walnut Creek is routed beneath Building 991 in a corrugated metal pipe. The discharge from the corrugated metal pipe is augmented by flow from a concrete pipe at a point north of the Mound Area. The flow from the concrete pipe originates as seepage from the hillside south of Building 991 and flows into a ditch along the slope. The combined flow then enters the South Walnut Creek retention pond system.

Below the retention ponds, South Walnut Creek, Walnut Creek, and an unnamed tributary join within the buffer zone before flowing into Great Western Reservoir. Great Western Reservoir is located approximately one mile east of this confluence.

The South Walnut Creek retention pond system (see Figure A-1) consists of five ponds (B-1, B-2, B-3, B-4 and B-5) that retain surface water runoff, and Plant discharges for the purpose of monitoring before downstream release of these waters. All flow in the pond system is eventually retained in Pond B-5 where it is monitored for quality before discharge in accordance with the Plant's National Pollutant Discharge Elimination System (NPDES) permit (discharge point 006). Ponds B-1 and B-2 are reserved for spill control, surface water runoff, or treated sanitary waste of questionable quality. Pond B-3 is used as a holding pond for sanitary sewage treatment plant effluent. The normal discharge of Pond B-3 is to a spray system located in the vicinity of the East Trenches. Ponds B-4 and B-5 receive surface water runoff from the central portion of the Plant, and occasional discharges from Pond B-3. The surface water runoff received by Pond B-4 is collected by the Central Avenue Ditch and upper reaches of South Walnut Creek.

Woman Creek

Woman Creek is located south of the Plant with headwaters in largely undisturbed Rocky Flats Alluvium. Runoff from the southern part of the Plant is collected in the South Interceptor Ditch located north of the creek and delivered downstream to Pond C-2 (Figure A-2). Pond C-1 (upstream of C-2) receives stream flow from Woman Creek. The discharge from Pond C-1 is diverted around Pond C-2 into the Woman Creek channel downstream. Water in Pond C-2 is discharged to Woman Creek in accordance with the Plant NPDES permit (discharge point 007).

Flow in Woman Creek and the South Interceptor Ditch is ephemeral. During 1986 and 1987, there was no visible surface flow in Woman Creek downstream of Pond C-2. The ephemeral nature of surface water flow observed for Woman Creek and the South Interceptor Ditch is due to changes in base flow conditions produced by the shallow ground-water table.

1.1.4 Meteorology and Climatology

Precipitation, principally from rainfall and to a lesser extent from snowmelt, produces surface runoff in the RFP area. The Rocky Flats Plant is situated in a semiarid region, averaging 15 inches of annual precipitation. Forty percent of the yearly total comes in the spring, much of it in the form of snow. Of the balance, 30 percent is accounted for by summer thunderstorms, with the rest occurring in the fall (11%) and winter months (19%). Average yearly snowfall averages 85 inches. Runoff control structures exist to channel surface water from the Plant to monitoring ponds. These structures are sized to accommodate the 100-year storm event which is equivalent to four inches of rain in a six hour period.

1.2 SURROUNDING AREAS

The Rocky Flats Plant (RFP) is located in northern Jefferson County, Colorado, approximately 16 miles northwest of downtown Denver. The Plant site consists of approximately 6,550 acres of federally-owned land in Sections 1 through 4, and 9 through 15, of T2S, R70W, 6th principal meridian. Plant buildings are located within an area of approximately 400 acres, known as RFP security area. The security area is surrounded by a buffer zone of approximately 6,150 acres.

1.3 SUSPECTED CONTAMINANT SOURCES

The IM/IRA Draft Decision Document, May 1990, describes the suspected contaminant sources in OU2. There are 20 sites designated as solid wastes management units (SWMUs) which comprise the 903 Pad, Mound and East Trench Areas. These sites are known collectively as Operable Unit No. 2, and are located east-southeast of the RFP (Figure A-1). The following sections describe each of the sites.

903 Pad Area

Five sites are located within the 903 Pad Area (Figure A-4). These sites are:

- 903 Drum Storage Site (SWMU Ref. No. 112)
- 903 Lip Site (SWMU Ref. No. 155)
- Trench T-2 Site (SWMU Ref. No. 109)
- Reactive Metal Destruction Site (SWMU Ref. No. 140)
- Gas Detoxification Site (SWMU Ref. No. 183)

Presented below are brief descriptions of each of these sites and the wastes stored or disposed there.

903 Drum Storage Site (SWMU Ref. No. 112) - The site was used from 1958 to 1967 to store drums containing radioactively contaminated used machine cutting oil. The drums, some of which corroded and leaked, contained oils and solvents contaminated with plutonium or uranium. Most of the drums contained lathe coolant consisting of mineral oil and carbon tetrachloride (CCl_4) in varying proportions. However, an unknown number of drums contained hydraulic oils, vacuum pump oils, trichloroethene (TCE), tetrachloroethene (PCE), silicone oils, and acetone. Ethanolamine was also added to new drums after 1959 to reduce the drum corrosion rate. All drums were removed by 1968.

After the drums were removed, efforts were undertaken to scrape and move the plutonium-contaminated soil into a relatively small area, cover it with fill material, and top it with an asphalt containment cover. This remedial action was completed in November 1969. An estimated 5,000 gallons of liquid leaked into the soil during use of the drum storage site. The liquid was estimated to contain 86 grams of plutonium.

903 Lip Site (SWMU Ref. No. 155) - During drum removal and cleanup activities associated with the 903 Drum Storage Site, winds distributed plutonium beyond the pad to the south and east. Although some plutonium-contaminated soils were removed, radioactive contamination is still present at the 903 Lip Site in the surficial soils.

Trench T-2 Site (SWMU Ref. No. 109) - This trench was used prior to 1968 for the disposal of sanitary sewage sludge and flattened drums contaminated with uranium and plutonium.

Reactive Metal Destruction Site (SWMU Ref. No. 140) - This site was used during the 1950s and 1960s primarily for the destruction of lithium metal. Small quantities of other reactive metals (sodium, calcium, and magnesium) and some solvents were also destroyed at this location.

Gas Detoxification Site (SWMU 193) - Building 952, located south of the 903 Drum Storage Site, was used to detoxify various bottled gases between June 1982 and August 1983.

Mound Area

The Mound Area is composed of four sites (Figure A-4). These are:

- Mound Site (SWMU Ref. No. 113)
- Trench T-1 Site (SWMU Ref. No. 108)
- Oil Burn Pit No. 2 Site (SWMU Ref. No. 153)
- Pallet Burn Site (SWMU Ref. No. 154)

These sites are described individually below.

Mound Site (SWMU Ref. No. 113) - The Mound Site contained approximately 1,405 drums containing primarily depleted uranium and plutonium contaminated lathe coolant. Some drums also contained "Perclene." Perclene was a brand name of tetrachloroethene. Some of the drummed wastes placed in the Mound Site were in solid form. Cleanup of the Mound Site was accomplished in 1970, and the materials removed were packaged and shipped to an off-site DOE facility as radioactive waste. Subsequent surficial soils sampling in the vicinity of the excavated Mound Site indicated 0.8 to 112.5 disintegrations per minute per gram (d/m/g) alpha activity. This radioactive

contamination is thought to have come from the 903 Drum Storage Site via wind dispersion rather than from the Mound Site.

Trench T-1 Site (SWMU Ref. No. 108) - The trench was used from 1954 until 1962 and contains approximately 125 drums filled with depleted uranium chips and plutonium chips coated with lathe coolant. The drums are still present in this trench.

Oil Burn Pit No. 2 Site (SWMU Ref. No. 153) - Oil Burn Pit No. 2 is actually two parallel trenches which were used in 1957 and from 1961 to 1965 to burn 1,083 drums of oil containing uranium. The residues from the burning operations and some flattened drums were covered with backfill. Cleanup operations were performed in the 1970s.

Pallet Burn Site (SWMU Ref. No. 154) - An area southwest of Oil Burn Pit No. 2 was reportedly used to destroy wooden pallets in 1965. The types of hazardous substances or radionuclides that may have been spilled on these pallets is unknown. Cleanup actions were performed in the 1970s.

East Trenches Area

The East Trenches Area consists of nine burial trenches and two spray irrigation areas (Figure 4). The trench numbers and their respective SWMU designations are:

- Trench T-3 - SWMU Ref. No. 110
- Trench T-4 - SWMU Ref. No. 111.1
- Trench T-5 - SWMU Ref. No. 111.2
- Trench T-6 - SWMU Ref. No. 111.3
- Trench T-7 - SWMU Ref. No. 111.4
- Trench T-8 - SWMU Ref. No. 111.5

- Trench T-9 - SWMU Ref. No. 111.6
- Trench T-10 - SWMU Ref. No. 111.7
- Trench T-11 - SWMU Ref. No. 111.8

Trenches T-3, T-4, T-10, and T-11 are located north of the east access road, and trenches T-5 through T-9 are located south of the east access road. The trenches were used from 1954 to 1968 for disposal of depleted uranium, flattened depleted uranium- and plutonium-contaminated drums, and sanitary sewage sludge. The wastes have not been disturbed since their burial.

SWMU numbers 216.2 and 216.3 were used for spray irrigation of sewage treatment plant effluent. These areas have been designated as solid waste management units because of the potential for chromium contamination that resulted from a Plant spill of chromic acid that entered the sanitary sewers on February 23, 1989. Based on results of sampling after the February spill, leachable chromium concentrations in soils were significantly below the RCRA Extraction Procedure (EP) Toxicity limits.

1.4 PROBABLE GROUNDWATER AND SURFACE WATER TRANSPORT PATHWAYS

Transport occurs in both groundwater and surface water. The sources were detailed above. Distribution in groundwater and surface water is discussed in Subsection 1.5.

1.5 CONTAMINANT DISTRIBUTION

Contaminants move from the groundwater system to the surface water system at seeps in the investigation area. The contaminants present in each area of OU2 are described in Subsections 1.5.1 and 1.5.2.

1.5.1 Groundwater Contamination

The following discussion is based on the information presented in the draft Surface Water Interim Measures/Interim Remedial Action Plan and Decision Document, May 25, 1990. Many seeps or stream stations were dry during some samplings. The following discussion of volatile organics, metals and inorganics focuses on groundwater sampling results for the second quarter of 1989. This information is presented in the IM/IRA Draft Decision Document for OU No. 2, May 1990. The discussion of 1989 radionuclide data in the IM/IRA report relies on first quarter results because complete second quarter data are unavailable.

1.5.1.1 Volatile Organic Contamination

Carbon tetrachloride (CCl_4), tetrachloroethene (PCE), and trichloroethene (TCE) are the primary volatile organic contaminants in the unconfined ground-water flow system.

Carbon Tetrachloride

Carbon tetrachloride (CCl_4) occurs in groundwater east, southeast and northeast of the 903 Pad Area. Of the downgradient wells in this area, 1-71 and 15-87 contain the highest levels of CCl_4 , 690 and 1100 micrograms per liter ($\mu\text{g/l}$), respectively. The downgradient concentrations (in wells 36-87 and 42-86) are greater than the upgradient concentrations (in wells 17-87 and 25-87). This indicates that the northern East Trenches may be a second source of CCl_4 .

Tetrachloroethene

The Mound Area appears to be the primary source of tetrachloroethene (PCE) within the area of investigation. Well 1-74 contained 45000 $\mu\text{g/l}$. A plume of PCE with concentrations greater than 100 $\mu\text{g/l}$ extends east and southeast (downgradient) from the Mound Area to at least well 36-87. The extent of this plume is not well defined. PCE was also detected in wells southeast (downgradient) of the 903 Pad and Trench T-2 (2-71, 15-87, and 1-71), although the concentrations were lower than in the Mound Area wells.

Trichloroethene

The distribution of trichloroethene (TCE) indicates that all three RI areas are sources of this volatile organic. TCE in wells 1-71, 2-71, 14-87, and 15-87 suggests the upgradient 903 Drum Storage Site and possibly Trench T-2 and the Reactive Metal Destruction Site as potential sources. Similarly, TCE in wells 1-74, 17-87, and 35-86 suggests the Mound Area as a source TCE downgradient of Trenches T-3 and T-4 and also indicates the East Trenches as potential sources. Well 36-87 within the latter area exhibited the highest concentration, 12000 $\mu\text{g/l}$.

Other Volatile Organic Compounds

Second quarter 1989 data indicate contamination in groundwater by volatile organic compounds other than CCl_4 , PCE and TCE, but to a much lesser extent. Details concerning the distribution of other volatile organic compounds is included in the IM/IRA Draft Decision Document, May 1990.

1.5.1.2 Inorganic Contamination

The IM/IRA Draft Decision Document contains details concerning the distribution of inorganic contamination in the OU No. 2 investigation area. The following summarizes the information contained in that document. Exact values and tables are contained in the Draft Decision Document.

Metals

Analytical data for waters from wells tested in the second quarter 1989, located at the 903 Pad, Mound and East Trenches Areas, showed above-background concentrations of all dissolved metals being measured except for beryllium, cadmium, cobalt, cesium, and thallium.

Radionuclides

Three uranium isotope concentrations (U-234, U-235, and U-238) were measured above background at the 903 Pad, Mound and East Trenches Areas, in the first quarter of 1989. For example, several wells within or downgradient of the 903 Pad Area exhibit uranium 238 in excess of background, with a maximum of 28 ± 2 pCi/l at well 12-87 (in weathered sandstone). Mound Area wells 23-87 (in weathered sandstone) and 17-87 (in Rocky Flats Alluvium) both contained uranium above background, whereas wells 1-74 (in weathered claystone) and 35-86 (in valley fill alluvium) did not contain above-background uranium. The only well that did not have above-background concentrations of uranium in the vicinity of the East Trenches Areas was 3-74 (in weathered claystone). The areal distribution of uranium in this area is not well known. In general, other radionuclides were not present above background in the first quarter of 1989, but there were earlier samples that contained plutonium and/or americium above background.

Results at wells 15-87 were the most elevated (plutonium - $0.522 \pm .117$ pCi/l and 0.199 ± 0.07 pCi/l; americium - 0.831 ± 0.148 pCi/l and $0.06 \pm .05$ pCi/l).

1.5.2 Surface Water Contamination

The following discussion is based on the information presented in the draft Surface Water Interim Measures/Interim Remedial Action Plan and Decision Document, May 25, 1990. Many seeps or stream stations were dry during some samplings.

1.5.2.1 Surface Water Stations Southeast of 903 Pad Area

This section describes locations of seeps in the area of investigation and gives an overview of contaminants found in some of these seeps. More detail, such as concentration of particular contaminants, is presented in tables located in Section 2.0 of the Treatability Study Plan (TSP).

There are several seeps downslope to the southeast of the 903 Pad (Figure A-1). Surface water stations that may be used in this investigation are seeps in the 903 Pad Lip Area designated SW-50, SW-51, SW-55, SW-57, SW-58, and SW-77. Station SW-50 is closest to the 903 Pad, and SW-57 and SW-52 are south of SW-50. SW-51 and SW-58 are located in a ditch along the road east of SW-50; however, overland flow of seepage from SW-50, SW-52, and SW-57 will also enter the ditch. Water in the ditch passes under the road south of these locations through a culvert. The discharge of the culvert is SW-55. SW-77, another seep located on the east side of the road, is just north of SW-55. It is noted therefore, that SW-51, SW-58, and SW-55 are physically connected and likely receive flow from SW-50, SW-52, and SW-57. Farther downgradient stations that may be used include seeps at SW-53 and SW-64.

Data for seeps in the vicinity of the 903 Pad Lip Site and farther downgradient at SW-53, SW-63, and SW-64 indicate organic contamination. Contaminants in seeps in the vicinity of the 903 Lip Site include 1,1-dichloroethene (1,1-DCE), 1,2-dichloroethene (1,2-DCE), CCl_4 , TCE and PCE with concentrations of CCl_4 and TCE exceeding $1000 \mu\text{g/l}$. 1,2-DCE and TCE are occasionally present at SW-53, low concentrations of CCl_4 and TCE occur at SW-63, and low concentrations of TCE occur at SW-64. Methylene chloride also occasionally occurs in these seeps. The volatile organic concentrations in the upgradient seeps suggest that a solvent plume within alluvial groundwater is migrating to the southeast, which is consistent with the alluvial ground-water flow direction. It is inferred that organic contaminated alluvial groundwater approaches the South Interceptor Ditch and Woman Creek.

With respect to inorganic and dissolved radionuclide contamination, the IM/IRA Draft Decision document reports elevated concentrations of TDS, major ions, strontium, zinc, and uranium at most of these stations. Although the 903 Pad Area cannot be ruled out as the source of the uranium, the occurrence of elevated uranium upgradient suggests the 881 Hillside Area as a potential source. Alluvial groundwater at the 881 Hillside contains above-background levels of uranium.

Seeps in the vicinity of the 903 Pad Lip Site (SW-50 and SW-53), had detectable plutonium and/or americium during one event in 1989 (two events for SW-53). The samples contained substantial suspended solids and were not filtered at the time of collection; surface soils in the vicinity of the seeps are contaminated with radionuclides. Furthermore, total radiochemistry data do indicate notably higher plutonium and americium concentrations than in filtered samples, demonstrating that most of the radionuclides are in a particulate form. Therefore, the local soils appear to represent a potential source for additional plutonium and americium contamination of water surfacing from seeps. However, the presence of trace concentrations of plutonium and

americium in a few ground-water samples (highest concentrations at well 15-87 - 0.522 ± 0.117 pCi/l and 0.031 ± 0.148 pCi/l, respectively) implies that groundwater is also a potential source of radionuclides in seeps. It is noted that plutonium and americium are essentially insoluble but that they can migrate in colloidal form. Colloidal-size particles can pass through $0.45 \mu\text{m}$ filters, such as those used in the Phase I RI.

Upper South Walnut Creek

At the Mound Area, station SW-60 is a corrugated metal pipe discharging South Walnut Creek flow which originates to the west of SW-56 (not sampled in 1989). Station SW-56 and SW-101 are on a ditch that appears to be seepage from the base of the hill to the south. The ditch is not part of the main flow of South Walnut Creek, as the creek is routed beneath this area by the corrugated metal pipe. Water in the ditch eventually discharges to South Walnut Creek through a concrete pipe. The flow in South Walnut Creek upstream of Pond B-4 is primarily the combined flow from the discharge of these culverts and a spring located at the base of the hill to the south and downstream of the culverts. This combined flow is sampled at SW-61 located at the confluence.

The upper reaches of South Walnut Creek as characterized by data for stations SW-56, SW-59, SW-60, SW-61, and SW-101 contain CCl_4 , PCE, and TCE in concentrations in excess of $200 \mu\text{g/l}$, with lesser and infrequent concentrations of 1,1-DCE, 1,1-DCA, 1,2-DCE, vinyl chloride, acetone, bromo-dichloromethane, and methylene chloride. These stations also frequently have above ARAR levels of TDS and uranium. The TDS and uranium concentrations are typical of the alluvial groundwater in the vicinity of the 903 Pad and Mound Areas. CCl_4 , PCE, TCE and elevated zinc are also present in the alluvial groundwater at the Mound Area.

1.5.2.3 East Trenches Areas

SW-101 has the constant presence of CCl_4 at concentrations less than $10 \mu\text{g/l}$. Like the 903 Pad and Mound Areas, the chemistry of this seep is similar to the local groundwater.

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IF SAMPLE VOLUME INADEQ.
- CHARACTERIZE TO ALLOW SIZES
- VOL. LOSS ON HANDLING → 10%

2.0 SAMPLING OBJECTIVE

Samples of surface water will be collected for use in the treatability study. Rather than obtaining water samples for characterization of water quality in OU2, the objective of this sampling program is to obtain samples which can be used to assess the performance of various treatment alternatives.

A primary requirement for water samples to be used in the treatability study is that the samples contain contaminant concentrations which are within the average to high range of concentrations historically exhibited at the site. This requirement, together with the hydrogeologic factors which may limit the number of sites available for sampling during the sampling event, are primary factors in sample location selection described in Section 3.1 and sampling procedures described in Section 5.0.

The surface water sampling activities will be conducted and documented in a manner to ensure that sufficient data of known quality are collected to support sound decisions concerning treatment selection. The data quality objectives (DQOs) used in design of the sampling program are as follows:

- 7 GRABS ON PONDAT FOR ~~ANAL~~ TESTING TUES (etc)
- Provide weekly volumes of surface water for use in treatability testing of the technologies listed in Section 3 of the Treatability Study Plan, Treatment Technologies.
 - Provide samples that, based on available data, contain contaminant concentrations representative of average to high levels compared with the contaminant concentrations recently determined to exist in the OU2 area.

3.0 SAMPLE LOCATION AND FREQUENCY

As discussed in Section 1.1, the hydrogeology, hydrology, and meteorology of the area will impact the number of sites available for sampling during the scheduled sampling period. The following subsections discuss constituents to be analyzed, the number and volume of samples to be taken, sampling locations, and proposed sampling dates.

3.1 SAMPLING LOCATIONS

Figure A-1 illustrates the locations of the sampling sites. The sites include:

SW50 SW51 SW52 SW53 SW55 SW56 SW57 SW58
SW59 SW60 SW61 SW63 SW64 SW77 SW101 SW103

○ = flowing
in late Sept

Of these 16 sites, six presently (September, 1990) contain water or are producing flow. The sites are SW56, SW59, SW60, SW61, SW64 and SW101. It is possible that fewer sites may contain water or be producing flow by October, 1990. Sites will be presurveyed for the presence of water available at the site for sampling within a short time period before each sampling date. Sites that contain water will be sampled.

As noted in Section 2.0, historic analytical data will be used, as available, to determine which of the surface water sites containing water at the time of a scheduled sampling event also possess the highest historic concentrations of contaminants. The sampling effort will concentrate on collecting as much water as is possible from such sites.

3.2 SAMPLING DATES

Four weekly sampling events are anticipated. These events are scheduled to occur on or about the dates listed in Section 5.0 of the TSP. The length of each sampling event may range in time from one to five days. This flexibility of the period of the sampling event is required because large volumes of water are required for use in the treatability testing, and volumes being produced by the seeps during the period in which sampling is anticipated to occur are typically small. Further, the volumes required for use in the treatability testing vary from week to week, with larger volumes expected to be required during the initial weeks of testing.

Slight variations in the concentrations of contaminants are expected to occur, given that the sampling events may each involve sampling of different sites from week to week. This variation is not an issue in the treatability tests, however, because the technologies under evaluation are noncompetitive. Slight variations in source material concentrations of contaminants will not effect efficiency of the technology being tested. Further, as discussed in Section 3.0 of the TSP, the samples will analyzed for concentrations of volatiles, and then spiked to particular levels. This will provide for consistency in treatment tests for these compounds.

3.3 CONSTITUENTS TO BE ANALYZED

The constituents to be analyzed are discussed in the Laboratory Sampling Plan, Section 2.1, Laboratories and Analytes.

3.4 NUMBER OF SAMPLES

A total of approximately 950 gallons of water sample are needed for use in the treatability studies. The volumes to be obtained each week for use in the treatability tests vary, depending upon the types of tests being performed during a given week. Table A-1 lists the volumes of surface water required for use in the treatability tests. The volumes of water listed on Table A-1 will include sufficient sample to perform (1) characterization of source material, as discussed in TSP Appendix A, Section 2, (2) treatability tests, as listed on Table A-1, and (3) sufficient residual for testing of end products.

The precise volumes water taken from a given site on a given date will depend on the flow conditions in existence at the time of the sampling event. Depending upon the number of sites containing water at the time of the sampling, approximately equal volumes will be collected at each site, if each site produces sufficient water to permit this. If a particular site is producing a low volume of flow, then low-flow sampling, as described in Surface Water SOP No. 7, Surface Water Sampling, will be performed. The collection bowl will be left in place for an extended period of time to collect as large a volume as possible on the date of the sampling event.

The water samples will be placed in large polyethylene carboys. These will have capacities ranging from about five to about 13 gallons per container. The surface water samples will be composited in the field. Prior to the weekly sampling event, existing hydrologic conditions will be assessed to determine the presence of water available for sampling at the sampling locations. Based on this information, one of two methods will be used to place the appropriate volume of sample from each site into the carboys. These two methods are to (1) mark increments on the carboys, and fill to each

TABLE A-1

VOLUMES OF SURFACE WATER REQUIRED
FOR TREATABILITY TESTS

liters

Test	Initial	Secondary	Final	Total
Gac-Rads	24 l	29 l		53 l
Gac-Orgs	24 l	72 l	15 l	111 l
Ion Exchange-Rads	44 l	44 l		88 l
Adsorb-Rads	15 l	44 l		59 l
Chem Coag/MF-Rads	32 l	75 l		107 l
Coag/Precip/Filt.-S.S.	75 l	30 l		105 l
Totals	214 l	294 l	15 l	523 l <i>liters</i>

incremental mark at each site or (2) collect sample in a graduated steel beaker, recording the volume added to each carboy at each site.

The incremental method is the preferred compositing method. This method will be performed as follows. The carboys will be incrementally marked so that a particular volume of water will be collected at each site into each sampling container. The containers will then be transported to the next sampling site, and will be filled to the next incremental mark on the carboy.

The volume measurement method will be used when sites possess so little flow that it may be necessary to collect all of the water in the sampling area more than once during the sampling day. The water will be dipped from the sampling site into a graduated stainless steel beaker or Teflon graduated cylinder. The entire volume of water will be collected, and this volume will be recorded in the sampling notes. The sampling team may then move to the next site, and repeat this procedure, returning to the previously sampled site later in the day to obtain more sample. This approach allows for a return to sampling sites to obtain additional sample after the site has again filled with water. This method is not preferred, because it is impossible to predict whether the surface water sites will regain sufficient volume to collect a desired volume of sample for the composite sample desired. Therefore, this method will only be used if extreme low-flow conditions exist at the time of the sampling events.

4.0
SAMPLE DESIGNATION

Samples will be identified in accordance with the numbering system described in Rocky Flats Plant Surface Water Data Collection Program Standard Operating Procedure No. 2, Sample Control and Documentation.

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5.0 SAMPLING EQUIPMENT AND PROCEDURES

5.1 SAMPLING PROCEDURES

Samples will be collected by methods described in Rocky Flats Plant Surface Water Data Collection Program Standard Operating Procedure No. 7, Rev. 1.0, Surface Water Sampling. Depending upon the volume of water available at a given sampling site, other samples will be collected by the method described in Subsection 5.3.1, Samples Collected by Container Immersion, or by procedures described in Subsection 5.3.8, Sampling Under Low Flow Conditions.

5.2 EQUIPMENT

Equipment that is to be used for sampling is described in Rocky Flats Plant Surface Water Data Collection Program Standard Operating Procedure No. 7, Rev. 1.0, Surface Water Sampling, in Subsection 5.2, Equipment for Collecting and Compositing Samples.

5.3 DECONTAMINATION

Sampling equipment decontamination and sample container decontamination procedures are described in Rocky Flats Plant Surface Water Data Collection Program Standard Operating Procedure No. 4, General Equipment Decontamination. Personnel decontamination procedures are described in Rocky Flats Plant Surface Water Data Collection Program Standard Operating Procedure No. 5, Level D Personnel Decontamination.

5.4 WASTE MANAGEMENT

Excess sample, waste resulting from sampling procedures, and waste resulting from decontamination procedures are to be contained for proper disposal. Procedures for Waste Management are described in Rocky Flats Plant Surface Water Data Collection Program Standard Operating Procedure No. 9, Waste Management.

by which the...

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6.0

SAMPLE HANDLING AND DOCUMENTATION

Sample preservation methods, shipping requirements, and holding times are described in Rocky Flats Plant Surface Water Data Collection Program Standard Operating Procedure No. 3, Sample Containers, Preservation, Handling, Packaging, and Shipping. For purposes of the sampling events to occur under this investigation, the following additional specific instructions apply:

- Samples will be placed in polyethylene carboys
- No chemical preservatives will be used for treatability samples
- Cooling will be used, as described in the above noted SOP

Sampling activities will be documented in accordance with the following Rocky Flats Plant Surface Water Data Collection Program Standard Operating Procedures:

- SOP No. 2: Sample Control and Documentation
- SOP No. 4: General Equipment Decontamination
- SOP No. 5: Level D Personnel Decontamination
- SOP No. 9: Waste Management
- SOP No. 13: Chain of Custody Procedures
- SOP No. 14: Logbook Protocol

7.0
REFERENCES

Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final. United States Environmental Protection Agency, EPA/540/G-89/004, OSWER Directive 9355.3-01, October 1988.

Data Quality Objectives for Remedial Response Activities: Development Process. EPA Contract No. 68-01-6939, March 1987.

Surface Water Interim Measures/Interim Remedial Action Plan and Decision Document - 903 Pad, Mound, and East Trenches Areas, Operable Unit No. 2. U.S. Department of Energy, Rocky Flats Plant, Golden, Colorado, May 25, 1990, Draft.

Hurr, R. Theodore. Hydrology of a Nuclear-Processing Plant Site, Rocky Flats, Jefferson County, Colorado. U.S. Geological Survey, Open-File Report 76-268, Denver, Colorado, March 1976.

Rocky Flats Plant Surface Water Data Collection Program Standard Operating Procedures, prepared by Woodward-Clyde, April 1990.

DRAFT

**APPENDIX A-2
LABORATORY ANALYSIS PLAN**

TABLE OF CONTENTS

	<u>Page</u>
1.0 INTRODUCTION	1
1.1 BACKGROUND	1
1.2 SAMPLING OBJECTIVES	3
2.0 SAMPLE IDENTIFICATION AND ANALYSIS	5
2.1 LABORATORIES AND ANALYTICAL METHODS	5
2.2 SAMPLE CONTAINERS AND PRESERVATION	5
2.3 SAMPLE IDENTIFICATION	5
3.0 SAMPLE COLLECTION	13
3.1 SAMPLE LOCATION AND FREQUENCY	13
3.1.1 Compositing Water Characterization	13
3.1.2 Granular Activated Carbon Treatment for Organics	13
3.1.3 Granular Activated Carbon Treatment for Radionuclides	20
3.1.4 Ion Exchange Treatment for Radionuclides	21
3.1.5 Adsorption of Radionuclides	21
3.1.6 Chemical Coagulation/Microfiltration for Radionuclides	22
3.1.7 Coagulation/Precipitation/Filtration for Suspended Solids	23
3.1.8 Solidification/Stabilization of Residuals	23

TABLE OF CONTENTS (Continued)

	<u>Page</u>
3.2 SAMPLING PROCEDURES	24
3.2.1 Compositing Water Sampling	26
3.2.2 Column Sampling	27
3.2.3 Jar Sampling	27
3.2.4 Solidified Residuals Sampling	27
3.2.5 QA/QC Sampling Procedures	28
3.2.6 Decontamination Procedures	30
3.2.7 Waste Disposal	31
4.0 SAMPLE HANDLING AND SHIPPING	32
4.1 HOLDING TIMES	32
4.2 SAMPLE TRACKING	32
4.3 SAMPLE CUSTODY	32
4.4 SHIPPING PROCEDURES	37

LIST OF TABLES

TABLE 2-1 LABORATORIES AND ANALYTICAL METHODS	8
TABLE 2-2 ANALYTE LIST FOR METALS SUITE	10
TABLE 2-3 ANALYTE LIST FOR VOLATILES SUITE	11
TABLE 2-4 SAMPLE CONTAINERS, PRESERVATIVES, AND HOLDING TIMES	12
TABLE 3-1 SAMPLE TYPE, LOCATION, AND FREQUENCY	14

TABLE OF CONTENTS (Continued)

Page

LIST OF FIGURES

FIGURE 4-1	SAMPLE CHAIN OF CUSTODY FORM	34
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1.1 BACKGROUND

The Department of Energy (DOE) wishes to pursue an interim remedial action for surface water at the 903 Pad, Mound, and East Trenches Areas, now termed Operable Unit No. 2 at the Rocky Flats Plant (RFP). In accordance with the Resource Conservation and Recovery Act of 1976 (RCRA) as amended by the Hazardous and Solid Waste Amendments of 1984 (HSWA), and the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), an Interim Measures/Interim Remedial Action (IM/IRA) is being conducted to minimize the migration of hazardous substances via surface water from areas that pose a potential long-term threat to the public health and environment. DOE is implementing an IM/IRA Plan because of the length of time it typically takes to finalize a RCRA Facility Investigation/Remedial Investigation (RFI/RI), and Corrective Measures Study/Feasibility Study (CMS/FS).

Organic and inorganic contamination of surface water has resulted from past operational practices no longer permitted under current regulations. EG&G has prepared an IM/IRA Plan to identify, screen, and evaluate appropriate interim remedial action alternatives, and select the preferred interim remedial action for the contaminated surface water.

A treatability study is designed to test remedial alternatives in the laboratory or field to obtain data necessary for a detailed evaluation of their feasibility (EPA, 1989). The Interagency Agreement between the USEPA, the State of Colorado, and DOE which

governs remedial actions at Rocky Flats Plant, describes a site-wide treatability plan and site-specific treatability studies, if the characteristics of the specific site require additional treatability studies.

The results of this treatability study are intended to evaluate the reduction of contaminants in Operable Unit No. 2 surface water which can be achieved by each treatment listed below and to determine whether the treatment may have undesirable effects, such as producing large quantities of residual materials or potentially hazardous byproducts. This information will then be available for further evaluation of each treatment method by more detailed methods, such as bench-scale studies with replicate measurements for statistical analysis, or pilot-scale studies of promising treatments.

This bench-scale treatability testing will include studies of the following:

- Granular activated carbon (GAC) for removal of volatile organic compounds (VOC) and selected radionuclides
- Coagulation/precipitation/filtration for removal of suspended solids
- Chemical coagulation and microfiltration for the removal of selected radionuclides
- Ion exchange for the removal of selected radionuclides
- Solidification/stabilization of test residuals
- Additional adsorption treatments for the removal of selected radionuclides

WC has subcontracted with a Denver-area laboratory (Hazen Research, Inc. of Golden, Colorado) for utilization of laboratory bench space and supplemental analytical services during the bench-scale treatability studies. This laboratory is off-site within reasonable driving distance of the Rocky Flats Plant so as to minimize transport of treatability samples from the site to the laboratory and travel time for EG&G and WC personnel

engaged in periodic review of the treatability activities. The laboratory has all required state and federal permits to allow receipt, storage, and treatability testing of hazardous, radioactive, and mixed waste samples at the facility. The laboratory is equipped with sufficient chemical and radionuclide analysis equipment and has personnel trained in its use to provide the supplemental analytical methods required to support the treatability studies. The Hazen Research, Inc. Quality Assurance plan will be filed by WC.

When USEPA-quality analytical services are required during the treatability test program (e.g., full analytical suite characterization of raw seep/surface water composites and final treated effluents from optimal treatment technology bench tests), samples of such materials will be sent to the contract laboratories selected under this task order.

1.2 SAMPLING OBJECTIVES

The results of this treatability study are intended to evaluate the reduction of contaminants in Operable Unit No. 2 surface water which can be achieved by each treatment listed above and to determine whether the treatment may have unintended effects, such as producing large quantities of residual materials or potentially hazardous byproducts. This information will then be available for further evaluation of each treatment by more detailed methods, such as bench-scale studies with replicate measurements for statistical analysis or pilot-scale studies of promising treatments.

Although designated a "bench-scale" treatability study by EG&G, this study combines elements of both laboratory screening and bench-scale treatability testing, as defined by the USEPA (USEPA, 1989). The term "laboratory screening" refers to tests that are limited in size and scope, such as small-scale jar tests or beaker tests, and designed to establish the validity of a technology to treat contaminants from an operable unit. This level of testing yields primarily qualitative data and is accompanied by minimum quality

assurance/quality control (QA/QC). Testing of chemical coagulation/microfiltration and coagulation/precipitation/filtration schemes to treat OU2 surface water will be at the laboratory screening level.

The term "bench-scale" testing refers to bench-top separation, reaction, or other treatment steps performed in the laboratory (or field) with equipment designed to simulate the basic operation of a treatment process. Bench-scale testing is intended to determine the technology's performance for the operable unit. This level of testing yields quantitative performance data and is accompanied by moderate to high levels of QA/QC. Testing of ion exchange resin columns, granular activated carbon columns, and other adsorption columns in this study will be at the bench-scale level.

These studies are intended to help characterize the untreated and treated surface water samples from OU2, before and after optimal treatment technology bench tests. These studies are not designed for site characterization of OU2.

2.0 SAMPLE IDENTIFICATION AND ANALYSIS

2.1 LABORATORIES AND ANALYTES

Four laboratories will be utilized for the analyses in the treatability study. These laboratories, the methods to be used, and the analytes of interest are shown on Tables 2-1, 2-2, and 2-3.

2.2 SAMPLE CONTAINERS AND PRESERVATION

Only sample containers certified as clean by the manufacturer will be used for sample collection. The containers and preservatives will be obtained from the contracted analytical laboratory. Required preservatives will be added to the containers by the contracted analytical laboratory, sampling team, and/or the on-site chemist prior to or during sample collection.

Table 2-4 shows the analytes of interest for water and solid matrices with the associated container size, preservatives (chemical and/or temperature), and holding times.

2.3 SAMPLE IDENTIFICATION

Each sample collected will have a unique sample identification number. These numbers will be assigned prior to the sampling event. The sample identification number will follow the format:

12ABC345

- The first two characters, shown as 12 in the example, represent the column number or run number that the sample was obtained from.
- The third, fourth, and fifth characters, shown as ABC in the example, code for the treatment method from which the sample was taken. Treatment method codes are as follows:

CWC Compositied Water Characterization

IEX Removal of radionuclides by Ion Exchange

GAR Removal of radionuclides by Granular Activated Carbon

CCM Removal of radionuclides by Chemical
Coagulation/Microfiltration

GAO Removal of volatiles by Granular Activated Carbon

CPF Removal of suspended solids by
Coagulation/Precipitation/Filtration

SSR Solidification/Stabilization of Residuals

AAR Activated alumina adsorption column

BCR Bone char adsorption column

FXR Filox adsorption column

- The seventh character, shown as 3 in the example, codes for the sample type. The sample type codes are as follows:

1 - Sample

2 - Duplicate

3 - Rinsate

4 - Filter rinsate

5 - Field blank

6 - Trip blank

7 - Treatment Blank

- The eighth and ninth characters, shown as 45 in the example, denote the specific sample number from the particular treatment and/or column run.

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TABLE 2-1

LABORATORIES AND ANALYTICAL METHODS

<u>LABORATORY</u>	<u>MATRIX</u>	<u>ANALYTE</u>	<u>METHOD</u>
TMA/NORCAL 2030 Wright Ave. Richmond, CA 94804 (415) 235-2633	Water	<u>Radionuclide Suite</u> Gross Alpha, Beta U ^{233,234,235,238} Pu ^{239,240} Am ²⁴¹	EG&G - Approved Methods
TMA/Skinner-Sherman 101 First Ave. P.O. Box 9046 Waltham, MA 02254 1-800-679-5599	Water Water	<u>Metals Suite</u> <u>Water Quality Parameters</u>	Flame AA
	Chloride Fluoride Carbonate/Bicarbonate Nitrate/Nitrite pH Sulfate		EPA Method 325.2 EPA Method 340.2 EPA Method 310.1 EPA Method 353.2 EPA Method 150 EPA Method 375.4

TABLE 2-1
(Continued)

Vista Laboratories, Inc. 3830 High Court Wheatridge, CO 80033 (303) 467-0630	Water	Total Dissolved Solids (TDS)	EPA Method 160.1
	Solid	Total Suspended Solids (TSS)	EPA Method 160.2
		Specific Conductivity	EPA Method 120.1
	<u>Volatile Suite</u>		EPA Method 8240
	<u>TCLP Suite</u>		
	TC Volatiles		EPA Method 8240
		TC Semivolatiles	EPA Method 8270
		TC Pesticides and Herbicides	EPA Method 8080
Hazen Research, Inc. 4601 Indiana St. Golden, CO 80403 (303) 279-4501	Water	TC Metals	Atomic Absorption
		Radionuclide Suite*	EG&G - Approved Methods
		Total Suspended Solids Screen	Gravimetric
		Total Organic Carbon Screen**	Coulometry
	Water	Gross Alpha/Beta Screen	Alpha-Beta Counting

* Sample of TCLP leachate to be sent to TMA/NORCAL for gross alpha/beta.

** Subcontracted to Huffman Labs, Inc.
4630 Indiana St.
Golden, CO 80403
(303) 278-4455

TABLE 2-2

ANALYTE LIST FOR METALS SUITE

Aluminum
Antimony
Arsenic
Barium
Beryllium
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Magnesium
Manganese
Mercury
Nickel
Potassium
Selenium
Silver
Sodium
Thallium
Vanadium
Zinc

TABLE 2-3

ANALYTE LIST FOR VOLATILES SUITE

Chloromethane
 Bromomethane
 Vinyl chloride
 Chloroethane
 Methylene chloride
 Acetone
 Carbon disulfide
 1,1-Dichloroethene
 1,1-Dichloroethane
 total 1,2-Dichloroethene
 Chloroform
 1,2-Dichloroethane
 2-Butanone
 1,1,1-Trichloroethane
 Carbon tetrachloride
 Vinyl acetate
 Bromodichloroethane
 1,1,2,2-Tetrachloroethane
 1,2-Dichloropropane
 trans-1,2-Dichloropropane
 Trichloroethene
 Dibromochloromethane
 1,1,2-Trichloroethane
 Benzene
 cis-1,3-Dichloropropene
 Bromoform
 2-Hexanone
 4-Methyl-2-pentanone
 Tetrachloroethene
 Toluene
 Chlorobenzene
 Ethylbenzene
 Styrene
 total Xylenes
 1,1-Dichloroethane

TABLE 2-4
SAMPLE CONTAINERS, PRESERVATIVES, AND HOLDING TIMES

Holding Parameter	Container	Preservative	Time
<u>Matrix-Water:</u>			
<u>Organic Compounds:</u>			
Volatiles Suite (VOCs)	2 x 40-mL VOA vials with teflon lined septum lids	Cool, 4°C ^a with HCl to pH<2	7 days 14 days
Total Organic Carbon Screen	100ml glass bottle	Cool, 4°C with H ₂ SO ₄ to pH<2	7 days 28 days
<u>Inorganic Compounds:</u>			
Radionuclide Suite	2 x 1-gallon polyethylene bottle	HNO ₃ to pH<2	6 mo
Gross Alpha/Beta	1-liter polyethylene bottle	HNO ₃ to pH<2	6 mo
Total Suspended Solids (TSS)	1 x 1-L polyethylene bottle	Cool, 4°C	7 days
Metals Suite	1 x 1-L polyethylene bottle	HNO ₃ to pH<2	6 mo ^b
Water Quality Parameters	1 x 1-L polyethylene bottle	Cool, 4°C	7 days
<u>Matrix-Solid:</u>			
Toxicity Characteristic Leaching Procedure (TCLP)	3 x 8-oz wide-mouth glass with Teflon®-lined lid closure	None	Extract 14 days, Analyze within 14 days

^a Add 0.008% sodium thiosulfate (Na₂S₂O₃) in the presence of residual chlorine

^bHolding time for mercury is 28 days.

3.1 SAMPLE LOCATION AND FREQUENCY

The numbers and types of samples to be collected differ for each treatment method. The sample collection frequency, analytes of interest, and QA/QC sample frequency for each treatment method are detailed below, and in Table 3-1.

3.1.1 Composited Water Characterization (CWC)

The composited water samples from the field will be characterized before their use in the treatment tests. It is anticipated that four composited water samples, spaced one week apart, will be utilized in the treatment tests. These waters will be sampled before their use in the treatment tests. They will be analyzed for the volatiles suite, metals suite, radionuclide suite, and the water quality parameters.

3.1.2 Granular Activated Carbon Treatment for Organics (GAO)

The granular activated carbon treatment for organics will be a column treatment. Treatment testing will consist of four rounds. A total of 26 column runs will be performed. Two runs will be performed on each of five different GAC columns in round one. One outlet sample will be collected from each run. Two additional inlet samples will be collected. Two QA/QC samples will also be collected. The 14 samples will be analyzed for pH, conductivity, and the total organic carbon screen.

Round two will consist of up to ten column runs; an additional two runs will be performed on each of up to 5 columns. One outlet sample will be collected from each

TABLE 3-1
SAMPLE TYPE, LOCATION, AND FREQUENCY

TREATMENT	TESTING ROUND	ANALYSES	NUMBER OF RUNS	SAMPLE FREQUENCY/TYPE	QA/QC SAMPLES	TOTAL NO. SAMPLES
CWC <i>Spec out</i>	N/A	Volatiles Suite Metals Suite Radionuclide Suite Water Quality Parameters	4 shipments	1 per week	none	4 weekly
	1	pH Conductivity Total Organic Carbon Screen	10	2 inlet 1 outlet per run	2 duplicates (1 inlet, 1 outlet)	2 inlet 10 outlet 2 QA/QC
GAO	2	Water Quality Parameters Volatiles Suite	up to 10	2 inlet 1 outlet per run	1 duplicate (outlet)	2 inlet
					1 MS/MSD (outlet) 1 field blank	10 outlet 5 QA/QC
					1 treatment blank 1 trip blank	17 total

TABLE 3-1 (Continued)

TREATMENT	TESTING ROUND	ANALYSES	NUMBER OF RUNS	SAMPLE FREQUENCY/TYPE	QA/QC SAMPLES	TOTAL NO. SAMPLES
CWC	N/A 3	Volatiles Suite	4 shipments	1 per week	none	4 weekly
		pH	3	1 inlet	2 duplicates (1 inlet, 1 outlet)	1 inlet
		Conductivity		4 outlet per run		12 outlet
		Total Organic Carbon Screen				2 QA/QC
GAO (cont'd)	4	Water Quality Parameters	3	1 inlet 1 outlet per run	1 duplicate (outlet)	1 inlet 3 outlet
		Volatiles Suite			1 MS/MSD (outlet)	5 QA/QC
					1 field blank	total
					1 treatment blank 1 trip blank	
GAR	1	pH	10	2 inlet	2 duplicates (1 inlet, 1 outlet)	2 inlet
		Conductivity		1 outlet per run		10 outlet
		Gross Alpha/Beta Screen				2 QA/QC
						14 total

TABLE 3-1 (Continued)

TREATMENT	TESTING ROUND	ANALYSES	NUMBER OF RUNS	SAMPLE FREQUENCY/TYPE	QA/QC SAMPLES	TOTAL NO. SAMPLES
CWC	N/A	Volatiles Suite	4 shipments	1 per week	none	4 weekly
		Water Quality Parameters	4	1 inlet	1 duplicate (outlet)	1 inlet
		Metals Suite		1 outlet per run	1 MS/MSD (outlet)	4 outlet
		Radionuclide Suite			1 field blank	4 QA/QC
					1 treatment blank	9 total
IEX	1	pH	18	2 inlet	2 duplicates (1 inlet, 1 outlet)	2 inlet
		Conductivity		1 outlet per run		18 outlet
		Gross Alpha/Beta Screen				2 QA/QC
						22 total
AAR, BCR, FXR	2	Water Quality Parameters	6	2 inlet	1 duplicate (outlet)	2 inlet
		Metals Suite		1 outlet per run	1 MS/MSD (outlet)	6 outlet
		Radionuclide Suite			1 field blank	4 QA/QC
					1 treatment blank	12 total
AAR, BCR, FXR	1	pH	18 runs	2 inlet samples	2 duplicates (1 inlet, 1 outlet)	2 inlet
		Conductivity		1 outlet per run		18 outlet

Sheet 3 of 6

22558/R3T-3-1 09-21-90/22558

TABLE 3-1 (Continued)

TREATMENT	TESTING ROUND	ANALYSES	NUMBER OF RUNS	SAMPLE FREQUENCY/TYPE	QA/QC SAMPLES	TOTAL NO. SAMPLES
CWC	N/A	Volatiles Suite	4 shipments	1 per week	none	4 weekly
		Gross Alpha/Beta Screen				2 QA/QC
						22 total
	2	Water Quality Parameters	6 runs	2 inlet	1 duplicate (outlet)	2 inlet
		Radionuclide Suite			1 field blank	8 QA/QC
					3 treatment blanks (1 each column)	16 total
CCM	1	pH Screen	16 jars	2 pre-coagulation	2 duplicates (1 pre-, 1 post-)	2 pre-
		Conductivity		1 post-coagulation per jar		16 post-
		Gross Alpha/Beta Screen				2 QA/QC
						20 total
	2	Water Quality Parameters	6 jars	2 pre-coagulation	2 duplicates (1 pre-, 1 post-)	2 pre-
		Metals Suite		1 post-coagulation per jar		6 post-
		Radionuclide Suite				2 QA/QC

TABLE 3-1 (Continued)

TREATMENT	TESTING ROUND	ANALYSES	NUMBER OF RUNS	SAMPLE FREQUENCY/TYPE	QA/QC SAMPLES	TOTAL NO. SAMPLES
CWC	N/A	Volatiles Suite	4 shipments	1 per week	none	4 weekly
						10 total
CPF	3	Water Quality Parameters Metals Suite Radionuclide Suite	6 jars	1 post-microfiltration per jar	1 duplicate	6 post-
						1 QA/QC
						7 total
CPF	1	Total Suspended Solids Screen	75 jars	2 pre-coag/precip	2 duplicates (1 pre-, 1 post-)	2 pre-
				1 post-coag/precip per jar		75 post-
						2 QA/QC
SSR	2	Total Suspended Solids (TSS)	15 jars	1 pre-filtration per jar	2 duplicates (1 pre-, 1 post-)	79 total
				1 post-filtration per jar		15 pre-
						15 post-
						2 QA/QC
SSR		TCLP Suite	6 residuals x 3 mix ratios = 18 mixtures	1 pre-solidification sample per residual		32 total
						6 pre-

TABLE 3-1 (Continued)

TREATMENT	TESTING ROUND	ANALYSES	NUMBER OF RUNS	SAMPLE FREQUENCY/TYPE	QA/QC SAMPLES	TOTAL NO. SAMPLES
CWC	N/A	Volatiles Suite	4 shipments	1 per week	none	4 weekly
	N/A			1 post-solidification sample per residual mixture	NONE	18 post-
						24 total

N/A = Not Applicable

of the column runs. Two additional inlet samples will be coll. Five QA/QC N samples will also be collected. All of the samples collected will be analyzed for the water quality parameters and the volatiles suite.

The third and fourth rounds of treatment testing will focus on column "breakthrough." Round three will consist of one column run on each of the three most effective GAC columns for organics removal. Four outlet samples will be collected during each of the three runs. Each outlet sample will be collected at a different time in order to determine column "breakthrough." One additional inlet sample will be collected. Two QA/QC samples will also be collected. All 15 samples will be analyzed for pH, conductivity, and the total organic carbon screen.

Round four will consist of three column runs. One additional run will be performed on each of the three most effective GAC columns (the same ones used in round three). One outlet sample will be collected from each of the column runs. Five QA/QC samples will also be collected. All 8 samples will be analyzed for the water quality parameters and the volatiles suite.

3.1.3 Granular Activated Carbon for Radionuclides (GAR)

The granular activated carbon treatment for radionuclides will be a column treatment. Treatment testing will consist of two rounds. A total of 14 column runs will be performed. In round one, two runs will be performed on each of five different GAC columns. One outlet sample will be collected from each of the ten column runs. Two additional inlet samples will be collected. Two QA/QC samples will also be collected. All 14 samples will be analyzed for pH, conductivity, and the gross alpha/beta screen.

Round two will consist of four column runs. An additional two runs will be performed on each of the two best GAC columns. One outlet sample will be collected from each of the column runs. One additional inlet sample will be collected. Four QA/QC

samples will also be collected. All nine samples will be analyzed for the water quality parameters, metals suite, and the radionuclide suite.

3.1.4 Ion Exchange for Radionuclides (IEX)

The ion exchange treatment for radionuclides will be a column treatment. Treatment testing will consist of two rounds. A total of 24 column runs will be performed. In round one, two column runs will be performed on each of the nine different resins. Each resin will be run using influents at two different pHs. One outlet sample will be collected from each of the 18 column runs. Two additional inlet samples will be collected. Two QA/QC samples will also be collected. All 22 samples will be analyzed for pH, conductivity, and the gross alpha/beta screen.

Round two will consist of six column runs. An additional two runs will be performed on each of the three best resins, at their best influent pH. One outlet sample will be collected from each of the column runs. Two additional inlet samples will be collected. Four QA/QC samples will also be collected. All 12 samples will be analyzed for the water quality parameters, metals suite, and the radionuclide suite.

3.1.5 Adsorption of Radionuclides (AAR, BCR, and FXR)

The adsorption column testing for radionuclides will be performed on three different column packing materials. Adsorption column tests for radionuclides using activated alumina (AAR), bone char (BCR), and Filox (FXR) will be performed. Treatment testing will consist of two rounds. A total of 24 column runs will be performed. Two runs on each of the three different columns, each at three different pHs, will be performed in round one. One outlet sample will be collected from each of the 18 column runs. Two additional inlet samples will be collected. Two QA/QC samples will

also be collected. All 22 samples will be analyzed for pH, conductivity, and the gross alpha/beta screen.

Round two will consist of six column runs. An additional two column runs will be performed on each of the three adsorbents at their best pH. One outlet sample will be collected from each of the column runs. Two additional inlet samples will be collected. Eight QA/QC samples will also be collected. All 16 samples will be analyzed for the water quality parameters, metals suite, and the radionuclide suite.

3.1.6 Chemical Coagulation/Microfiltration for Radionuclides (CCM)

The chemical coagulation/microfiltration treatment for radionuclides will be a jar test. Treatment testing will consist of three rounds. A total of 28 coagulation jar tests will be performed. Jar tests on four different coagulants, each tested at four different concentrations, will be performed in round one. One post-coagulation supernatant sample will be collected from each of the 16 jar tests in round one. Two additional pre-coagulation samples will be collected. Two QA/QC samples will also be collected. All 20 samples will be analyzed for pH, conductivity, and the gross alpha/beta screen.

Round two will consist of six jar tests. One additional test on each of the four coagulants at their most effective concentration will be tested, along with two other coagulant/concentration combinations. One post-coagulation sample will be collected from each of the jar tests. Two additional pre-coagulation samples will be collected. Two QA/QC samples will also be collected. All ten samples will be analyzed for the water quality parameters, metals suite, and the radionuclide suite.

Round three will consist of six jar tests. Supernatant from each of the six treatment jars used in round two will be further treated by microfiltration. One post-microfiltration

sample will be collected from each of the jar tests. One QA/QC sample will also be collected. All seven samples will be analyzed for the water quality parameters, metals suite, and the radionuclide suite.

3.1.7 Coagulation/Precipitation/Filtration for Suspended Solids (CPF)

The coagulation/precipitation/filtration treatment for suspended solids will be a jar test. Treatment testing will consist of two rounds. A total of 90 coagulation/precipitation jar tests will be performed. In round one, 75 jar tests will be performed. Round one jar tests will be performed on five different coagulants, each of which will be tested at five different concentrations, of which each will be tested at three different pHs. One post-coagulation/precipitation supernatant sample will be collected from each jar test. Two additional pre-coagulation/precipitation samples will be collected. Two QA/QC samples will also be collected. All 79 samples will be analyzed for the total suspended solids screen.

Round two will consist of 15 jar tests. Supernatant from each of the best 15 treatment jars from round two will be further treated by filtration. One pre-filtration sample and one post-filtration sample will be collected from each of the jar tests. Two QA/QC samples will also be collected. All 32 samples will be analyzed for total suspended solids (TSS).

3.1.8 Solidification/Stabilization of Residuals (SSR)

The solidification/stabilization of residuals treatment will be tested by the Toxicity Characteristic Leaching Procedure (TCLP). Residuals from the two best adsorption columns, the two best ion exchange columns, and the two best granular activated carbon for volatiles columns will be treated. A pre-solidification sample will be collected from

each of the six column residuals. Each residual will then be mixed with Portland cement, in three different ratios. A post-solidification sample will then be collected from all 18 solidified residuals. All 24 samples will be analyzed for the full TCLP suite.

3.2 SAMPLING PROCEDURES

The collection techniques, choice of sample containers, preservatives, and equipment are all critical to ensure that samples are not altered or contaminated. Regardless of the collection method, care should be taken to prevent alteration of the chemical nature of the sample by agitating the sample or allowing prolonged contact with the atmosphere during collection.

VOC vials will be filled by dispensing water along the inside edge of the slightly tilted sample vial. Care will be taken to eliminate aeration of the sample water. The vials will be filled beyond capacity so the resulting meniscus will produce an airtight seal when capped. The capped vial will be checked for trapped air by lightly tapping the vial in an inverted position. If air becomes trapped in the vial, the sample water will be discarded, and a new vial will be filled. VOC vials will never be filled and stored below capacity because of insufficient quantities of water.

Except for the VOC vials, adequate air space should be left in the bottle to allow for expansion.

Prior to sample collection, the sample bottles will be labeled by the sample manager. Collection time and date will be marked by the sampler. The labels will indicate:

- Activity name and/or number
- Unique sample number

- Sampling time and date
- Chemical preservative used
- Sample type (grab, composite)
- Analyses required
- Filtered/unfiltered
- Comments or special precautions, as needed
- Samplers Initials

The sample label will be marked with a black waterproof pen. If needed, clear tape will be placed over labels before sampling to assure that the labels remain legible.

All field descriptions, measurements, and observations are to be recorded in a field logbook. Field data will be filled out at the time a sample is taken and will include, but not be limited to the following information:

- Sampling activity name and number
- Sampling point name and number
- Sample number*
- Name(s) of collector(s) and others present
- Date and time of sample collection*
- Sample container tag number (if appropriate)*
- Preservative(s) used*
- Requested analyses*
- Sample matrix*
- Filtered/unfiltered*
- Designation of QC samples* (ONLY for MS and MSD)
- Collection methods

* Items will be documented on the COC form

- Chain of custody control numbers
- Field observations and measurements during sampling (comment section)
- Signature of responsible observer

Subsequent to sampling, the exterior of the sample containers will be decontaminated by rinsing with distilled water and wiping dry, sealed in plastic bags, and placed in coolers dedicated to samples and sample container transportation. The temperature in the coolers will be maintained at $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$ by adding sealed plastic bags containing blue ice (or an equivalent) to the coolers.

During the initial stages of field work, the sample manager will use a thermometer to verify that an adequate amount of blue ice is being used to maintain sample temperature at approximately $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$.

3.2.1 Composited Water Sampling

Composited water samples will be delivered to the Hazen Research, Inc. in a nalgene carboy. Care will be taken to minimize agitation of the collected waters. Collected water will be allowed to settle prior to use in treatability testing. Composited waters will be sampled from the top of the carboy using a pipet. The interior of the pipet will be triple rinsed with the sample water before the actual sample is collected. The sample will be taken from the top inch of the water in the carboy. The pipet will then be allowed to drain into the appropriate sample container. The sample for volatiles will be collected as soon as possible after the carboy is opened in order to prevent analyte volatilization. Pipets will be decontaminated after use as specified in section 3.2.5.

3.2.2 Column Sampling

Inlet and outlet samples from column treatments will be taken from a 3-way stopcock on the top (inlet) or bottom (outlet) of the adsorption column. Flushing and sampling must occur from an uninterrupted flow (i.e. the stopcock will be opened once at the onset of flushing, and not closed until after all the samples have been taken). The stopcock is to be fully opened and allowed to flush a volume equivalent to approximately 3 times the volume between the stopcock and the tubing outlet. Samples will then immediately be collected for the analytes of interest.

Inlet sampling will be performed on the first column run of each treatment test. When the treatment test will span a period of more than one day, an inlet sample will be collected from the first column run as well as the last column run.

3.2.3 Jar Sampling

Pre-treatment and post-treatment samples for jar tests will be taken directly from the jar by pipet or siphon. The interior of the pipet or siphon tube will be triple rinsed with the sample before the actual sample is collected. The sample will be taken from the top centimeter of liquid in the jar. The pipet will then be allowed to drain into the appropriate sample container. Pipets and siphon tubes will be decontaminated after use as specified in Subsection 3.2.5.

3.2.4 Solidified Residuals Sampling

Samples from the solidification/stabilization treatment will be collected before the concrete-residual mixture has set. The wet concrete-residual mixture will be poured directly into the appropriate sample container, and allowed to solidify in that container.

After solidification is complete, the container will be capped and sent to the appropriate laboratory for analysis.

3.2.5 QA/QC Sample Procedures

There are six types of QA/QC samples: duplicate samples, equipment rinsate, treatment blanks, trip blanks, field blanks, and matrix spike/matrix spike duplicates. Field QA/QC samples will be chosen on a random basis from the available population for the specific field QA/QC sample type.

Duplicate Samples

Field duplicate samples are independent samples collected in such a manner that they are, to the extent possible, equally representative of the parameter(s) of interest at a given point in time. The sample bottle will first be filled, followed by the duplicate sample bottle. Duplicate samples will be analyzed for the same analytes as the original sample.

Equipment Rinsates

Equipment rinsate samples are obtained by pouring analyte-free distilled water through sample collection equipment (pipets, beakers, spatula, auger etc.) after decontamination and collecting the rinsate in the appropriate sample container for chemical analysis. The rinsate will be taken on the specific equipment used in the sample collection. Equipment rinsate samples will be analyzed for the same methods as the associated original samples. These samples will be used to determine the effectiveness of the decontamination procedures and to ensure that decontamination procedures are properly followed.

Treatment Blanks

Treatment blanks are obtained by running analyte-free distilled water through the proposed treatment/column. The treatment blank is run through the specific treatment/column used to generate the treated sample before the treated sample is generated. Treatment blanks will be used to verify that the treatment/column itself is not a source of sample contamination.

Trip Blanks

Trip blanks are prepared prior to the sampling event by the analytical laboratory in 40-ml VOA containers and are kept with the VOC sample coolers throughout the sampling and transportation events. They are then packaged for shipment with the samples and sent for analysis. At no time after their preparation are the sample containers opened before they reach the laboratory. Trip blanks will be analyzed for volatile organics only.

Field Blanks

Field blanks are prepared in the field during a sampling event. Sample bottles identical to those used for chemical analysis samples will be filled with distilled water in a manner similar to the sampling procedure. This process includes using the same personnel, location, and equipment whenever possible. These samples will be used to evaluate the possibility of contamination because of the sampling environment.

Matrix Spikes/Matrix Spike Duplicates

Matrix Spike and Matrix Spike Duplicate samples are independent samples collected in such a manner that they are, to the extent possible, equally representative of the

parameter(s) of interest at a given point in time. The matrix spike (MS) and matrix spike duplicate (MSD) are used by the contracting laboratory as a QA/QC check. The same procedure used for collecting field duplicate samples will be followed when collecting the MS and MSD samples.

3.2.6 Decontamination Procedures

Sampling tools, instruments, and equipment will be protected from sources of contamination before use and decontaminated after use. Liquids and materials from decontamination operations will be properly disposed. Sample containers will also be protected from sources of contamination. Sampling personnel will wear chemical-resistant gloves when handling samples. Gloves will be decontaminated or disposed of after each sampling event.

When sampling equipment is used to collect samples that contain oil, grease, or other hard to remove materials, it may be necessary to steam clean the equipment before proceeding with Step 1. If the field equipment cannot be cleaned utilizing these procedures, it should be discarded.

1. Wash equipment thoroughly with laboratory detergent and tap water and use a brush to remove any particulate matter or surface film.
2. Rinse equipment thoroughly with tap water.
3. Rinse equipment thoroughly with distilled water.

4. If the equipment is not decontaminated immediately after use, the sampling equipment should be thoroughly rinsed with tap water in the field as soon as possible after use.

3.2.7 Waste Disposal

All wastes generated by decontamination and sampling of treated waters will be disposed of as specified in the Treatability Study Work Plan.

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4.1 HOLDING TIMES

Sample containers, sample preservatives, and sample holding times are shown in Table 2-4.

4.2 SAMPLE TRACKING

Information records and tracking of samples will be accomplished by a Woodward-Clyde computer program. This program will calculate the expiration of holding times based on sample collection dates, and extraction and analysis holding time criteria for each specific method of analysis requested on a particular sample. Extraction and analysis holding times are calculated each day, and for every sample in the database. This program will identify samples with holding times that are within two days of expiration. The laboratory will then be contacted to verify that sample analysis has started. The total number of field samples, specific analytes, and associated chains of custody generated during the sampling activity will be compared with the requested analytical results. This process is to ensure that the samples collected in the field were analyzed by the contract laboratory as specified in this sampling plan.

4.3 SAMPLE CUSTODY

Official custody of samples must be maintained and documented from the time of collection until the time that valid analytical results have been obtained or the laboratory has been released to dispose of the sample. The sampling team will be responsible for initiating the original chain of custody (COC) form and will sign and date this form when

relinquishing custody of samples to the sample manager. Upon receipt, the sample manager will check the COC and all sample labels to ensure that all samples are accounted for and in good condition, and that no errors were made in labeling and/or completing the COC. A sample chain of custody form is shown in Figure 4-1.

A sample is considered to be in a person's custody if any of the following conditions are met:

- The sample is in the person's physical possession.
- The sample is in line of sight of the person after he/she has taken possession.
- The sample is secured by that person so that any tampering can be detected.
- A sample is secured by the person in possession in an area which only authorized personnel can enter.

If, at any time after samples have been secured, custody seals are identified as having been tampered with, this procedure will be followed to ensure that sample integrity has not been compromised:

- Check cooler temperature to verify $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$
- Check with all personnel having access to sample coolers to verify possible inadvertent tampering
- Check every sample container for any signs of tampering i.e. loose lids, foreign objects in containers, broken or leaking containers, etc.

Job No. :	22558
Prepared by :	BRC
Date :	9/19/90



- Check to assure adequate and appropriate packaging
- Document all findings of the incident in the sample manager's field log book

If it is determined that malicious tampering of samples has occurred and/or it is believed that sample integrity has been compromised, the sample manager will immediately contact Mr. Steven Baca of Woodward-Clyde Federal Services at 740-2700.

If it can be determined that sample integrity has not been compromised based on the above criteria, findings should be documented in the sample manager's field logbook, and sample collection activities should resume.

An example of a three-page carbonless COC form is shown in Figure 4-1. The original and second (yellow) copy will be included with the samples to be shipped enclosed in a plastic bag and taped inside the lid of the cooler. The third (pink) copy along with a photocopy of the original will remain on file at the on-site facility. The contract laboratory will sign as having received the samples and return the yellow copy of the COC to the project management office for verification by the QA/QC officer or their designee. The yellow and pink copies will then be matched and filed to complete the chain of custody procedure.

The chain of custody form will include the following information:

- Unique sample number and sample location
- Project number
- Date and time of sample collection

- Signature of collector or field custodian
- Laboratory designation
- Sample matrix
- Condition of sample on receipt at the laboratory
- Chain of custody control number
- Signature and date blocks for personnel relinquishing or receiving sample custody
- Space for additional comments
- Name and phone number of emergency contact person
- Analysis requested
- Out of spec reporting

If a chain of custody (COC) record should become lost during shipment or after receipt by the laboratory, the sample manager (or designee) will fill out a new form using information from the file copy of the original. In the "remarks" section of the replacement COC, BOTH COC numbers (located in the upper left hand corner of every COC form) will be written down and the new COC and file copies of the original COC will be attached and filed at the onsite facility to document the losing and replacement of chain of custody for the associated samples.

If it becomes necessary to make changes/deletions/corrections or any modifications to the original chain of custody form after it has left the sampling site, the following procedure will be followed:

- Direct telephone communication between the sample manager or designee and the chemical laboratory sample custodian or designee to verify that a modification must be made to an original COC form
- Verbal agreement by both parties on the modification to be made

- Each party will make the change on their respective copy of the original COC, initialing and dating each modification
- The originating party of the original COC (i.e., sample manager) will fax a copy of the modified COC to the laboratory for visual verification of modifications to ensure corrections were made accordingly. This process is to be completed within 24 hours of modifications.
- The lab, upon receipt of the fax, will contact the sample manager and verify receipt of correct modifications. The lab will send a copy of their modified COC to the sample manager.

4.4 SHIPPING PROCEDURES

All sample containers will have been decontaminated and bagged at the time of sample collection. Upon receipt and verification of sample containers and COC forms, the sample manager will take the following steps:

- Line the sample cooler with a large plastic bag.
- Place approximately 3 inches of vermiculite in the bottom of the cooler.
- Wrap glass containers in bubble pack.
- Verify that all samples requiring screening have reported estimated radiological activity levels.

- Place bagged and wrapped sample containers upright, except for the volatile organic compounds (VOC) vials, in the cooler with approximately 1 inch between them and the sides of the cooler.
- Fill the cooler approximately three quarters full of vermiculite, making sure that sample containers are securely packed.
- Insert the two VOC vials upright in the center of the cooler.
- Fill the cooler with vermiculite, allowing adequate space at the top for blue ice.
- Bag the blue ice (or equivalent) and place several packages in the top space of the cooler**
- Seal the signed COCs in a plastic bag and tape it to the underside of the lid of the cooler.
- Tape the drain of the cooler shut.
- Wrap strapping tape around the cooler in two locations to secure the lid.
- Place the airbill on top of the cooler. If more than one cooler is sent to the same laboratory, an address label and a manifest label are needed.
- Place "This Side Up" labels on all four sides and "Fragile" labels on the top and two sides of the cooler.

** See Table 2-4 for analytes requiring $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$.

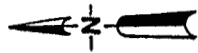
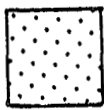
- Place "Environmental Samples" label on top of cooler. For coolers over 75 pounds, an additional "Heavy Weight" label is required in the upper left corner on top of the cooler.
- Place signed and dated custody seals in two locations sealing the cooler lid so that tampering will be evident.

Sample coolers may be received by courier at a pre-determined area. If arrangements cannot be made, a Company vehicle is required to deliver sample coolers to the laboratory and/or courier office.

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LEGEND

ALLUVIAL MATERIALS



0 300' 600'
SCALE IN FEET

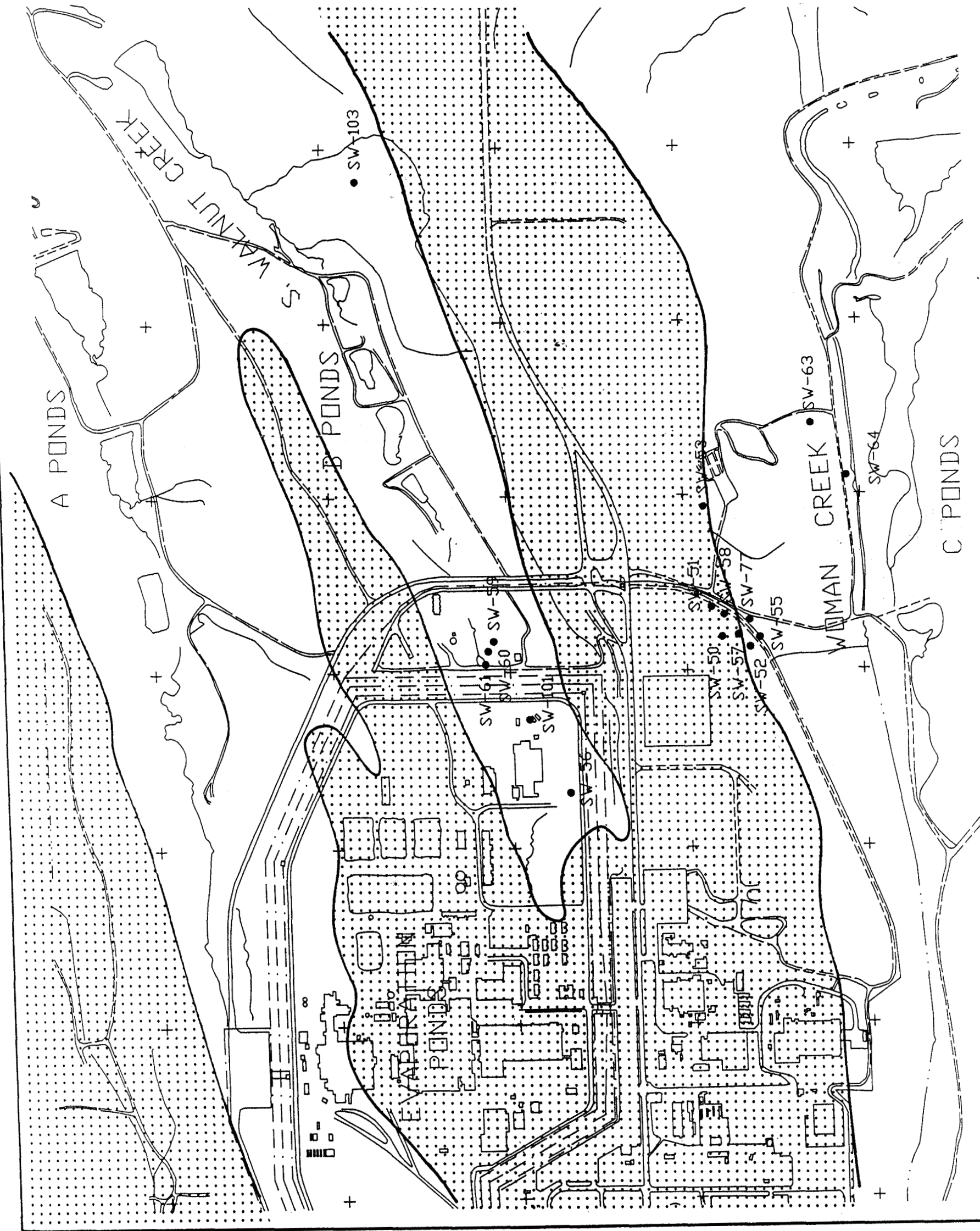
CONTOUR INTERVAL = 20'

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FIGURE A-1

SURFACE WATER SAMPLING SITES
AND ALLUVIUM LOCATIONS

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EXPLANATION

SOLID WASTE MANAGEMENT UNIT (SWMU)

POTENTIOMETRIC SURFACE
ELEVATION (feet above
mean sea level)

5798

ALL DATA BASED ON MEASUREMENTS
MADE APRIL 4-8, 1988 INCLUSIVE

LINE OF EQUAL POTENTIOMETRIC
SURFACE ELEVATION (feet
above mean sea level)—DASHED
WHERE APPROXIMATELY LOCATED

5860

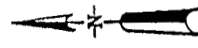
NO DATA

ND

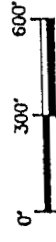
B217489 ● BEDROCK MONITOR WELL

B213789 ○ ALLUVIAL MONITOR WELL

0382 ▲ PRE-1986 MONITOR WELL



Scale: 1" = 600'



CONTOUR INTERVAL = 20'

Source: Surface Water Interim Measures/Interim
Remedial Action Plan and Decision Document
-903 Pad Mound, and East Trenches Areas,
Operable Unit No. 2, U.S. Department of Energy,
Rocky Flats Plant, Golden, Colorado, May 25,
1990, Draft.

U.S. DEPARTMENT OF ENERGY

Rocky Flats Plant

Golden, Colorado

OPERABLE UNIT NO. 2
SLURFACE WATER IM/IRA

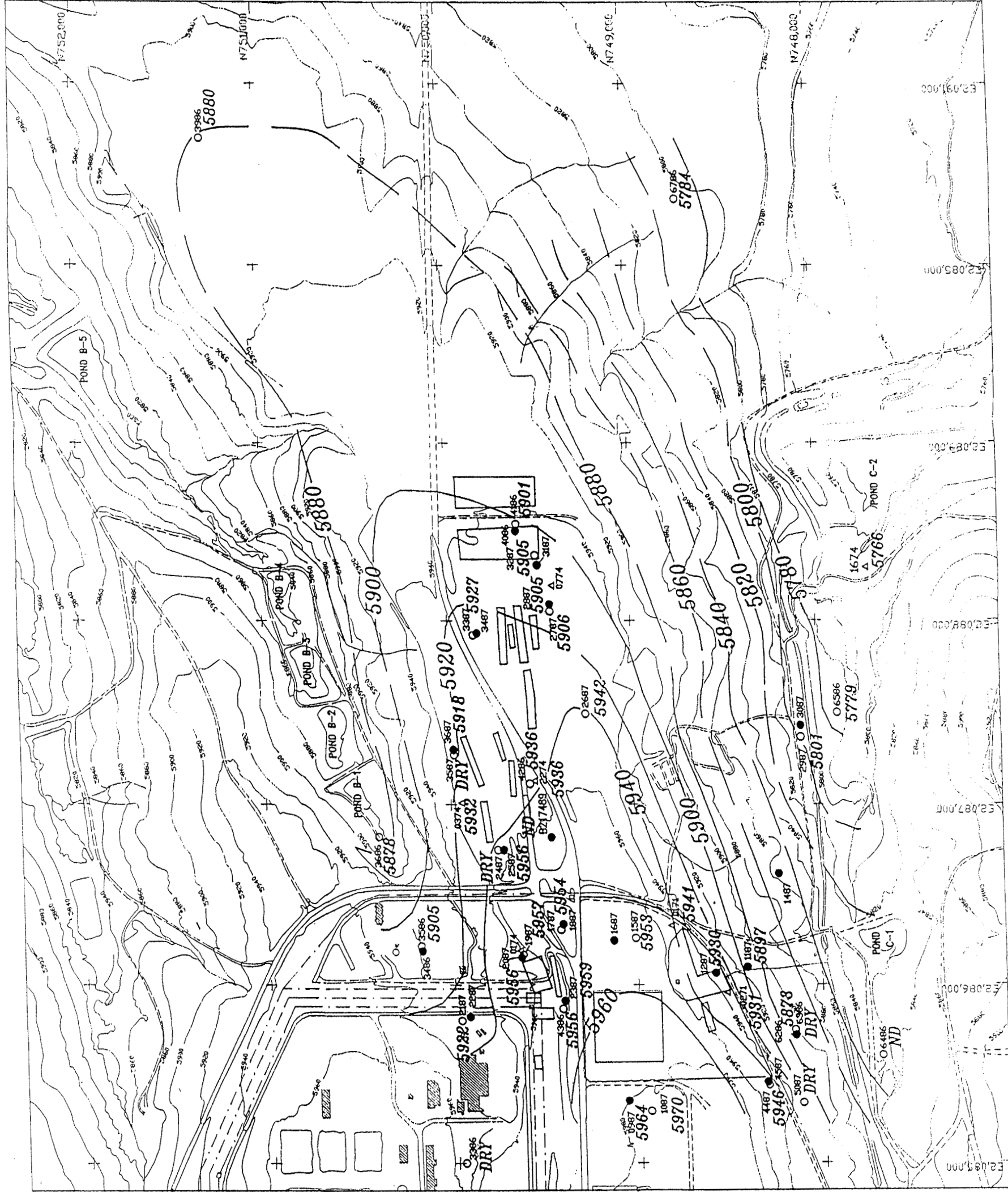
FIGURE A-2

POTENTIOMETRIC SURFACE OF
UNCONFINED GROUND-WATER
FLOW SYSTEM

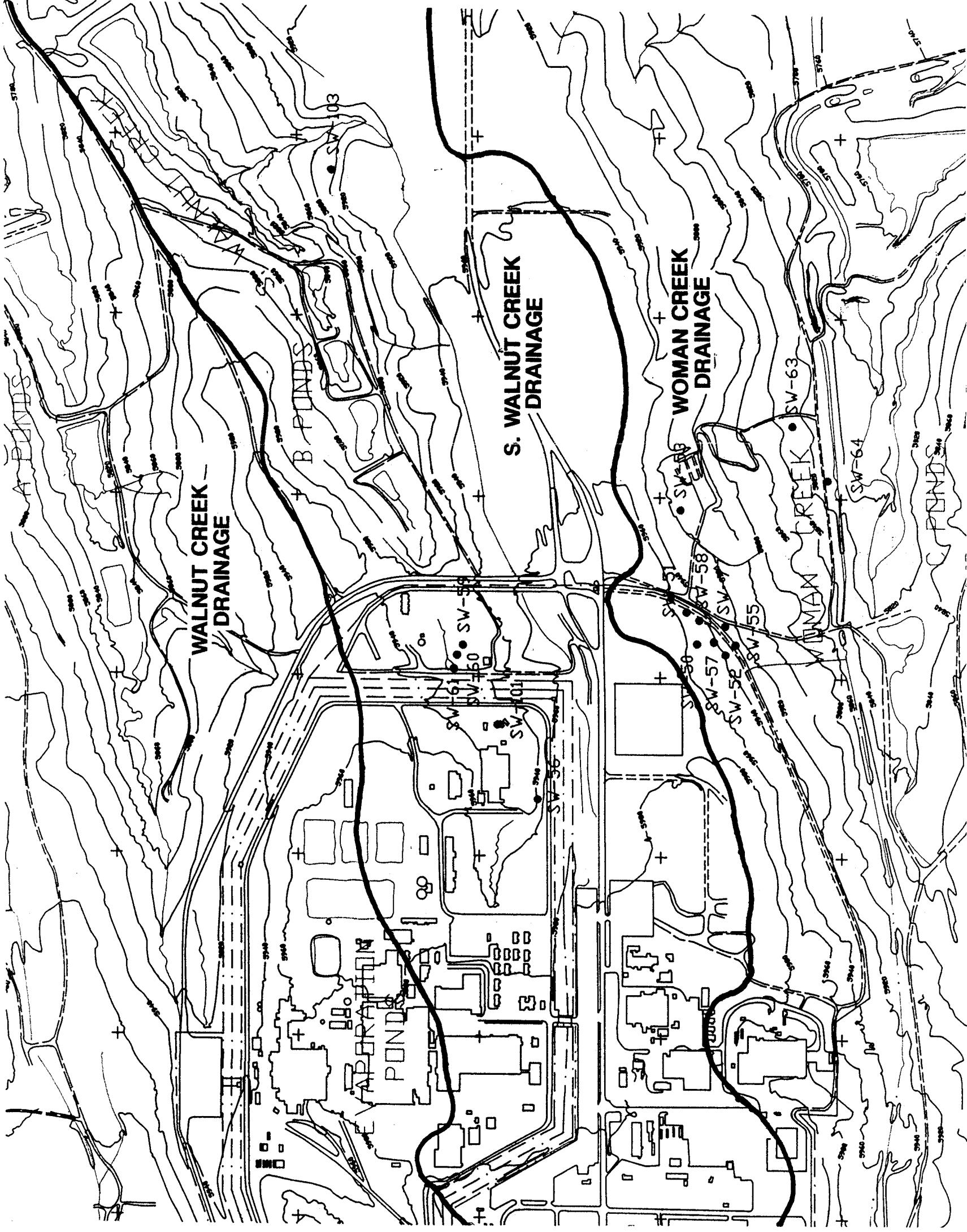
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LEGEND



0 300' 600'

SCALE IN FEET

CONTOUR INTERVAL = 20'

Source: Hurr, R. Theodore. Hydrology of a Nuclear-Processing Plant Site, Rock Flats, Jefferson County, Colorado. U.S. Geological Survey, Open-File Report 76-268. Denver, Colorado, March 1976.

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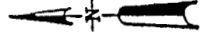
FIGURE A-3

DRAINAGE BASINS

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EXPLANATION

- SOLID WASTE MANAGEMENT UNIT (SWMU) AND SWMU DESIGNATION
- LOCATION OF BARRELS DETERMINED BY VISUAL INSPECTION OR MAGNETOMETER SURVEY
- REMEDIAL INVESTIGATION AREAS



Scale: 1" = 600'

0' 300' 600'

CONTOUR INTERVAL = 20'

Source: Surface Water Interim Measures/Interim Remedial Action Plan and Decision Document -903 Pad Mound, and East Trenches Areas, Operable Unit No. 2, U.S. Department of Energy, Rocky Flats Plant, Golden, Colorado, May 25, 1990, Draft.

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OPERABLE UNIT NO. 2
SURFACE WATER IM/IRA

FIGURE A-4

REMEDIAL INVESTIGATION AREAS
AND SOLID WASTE
MANAGEMENT UNITS

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